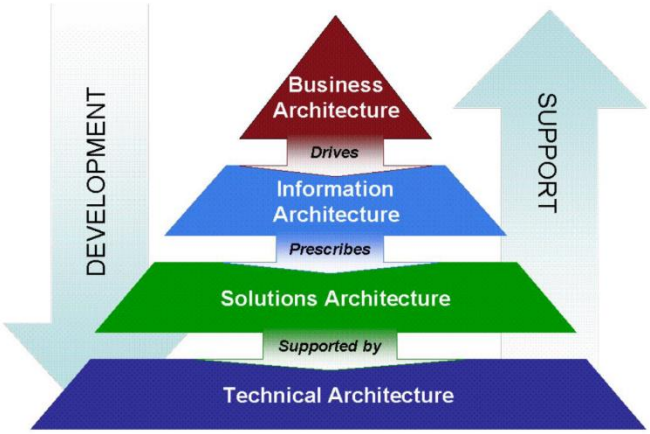
Virginia Information Technologies Agency

Enterprise Architecture Technical Brief

Oracle, IBM DB2, and SQL RDBMS'

Robert Kowalke
November 2017



Contents

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Database Recommendation

Oracle, SQL Server, and DB2 are powerful RDBMS options. There are a number of differences in how they work "under the hood," and in various situations, one may be more favorable than the other. [1] There is no easy answer, nor is there a silver-bullet for choosing one of these three (3) databases for your specific business requirements.

Oracle is a very popular choice with the Fortune 100 list of companies and for larger enterprises. Research indicates Oracle is popular with large business applications and large data warehouses. Those looking for the largest amount of features will most likely choose Oracle because it is packed with features and minimizes the need for additional third party software to enhance its capabilities. [2]

Oracle

- Use Oracle if: [3]
    - You require transaction control flexibility.
    - You plan to host a large database.
    - You require a high degree of scalability.
    - You want your database to be platform-independent.
    - Faster than DB2 for short running queries. [4]

- G2's Voice of the Users mentions the following: [5]
    - What do you like the best about Oracle?
        - Oracle's interface is easy to use. I can navigate through multiple programs and sub-options.
        - I had been using MySQL at my previous job; this has been like stepping into a race car. It's fast and it feels like it was put together by professionals. Documentation is readily available and support is easy to find.
    - Recommendations to others considering the product

[1] Microsoft SQL Server vs. Oracle: The Same, But Different? By Josh Stansfield of Segue III Technologies on March 13, 2014. Retrieved from http://www.seguetech.com/microsoft-sql-server-vs-oracle-same-different/ on June 5, 2017.
[2] When is Oracle the Better Choice? by ITX Design Retrieved from https://itxdesign.com/mysql-vs-oracle/ on June 6, 2017.
[3] Oracle vs. MySQL vs. SQL Server vs. PostGRESQL: Which DBMS Is The Best Choice For You? by Liberty Center One, an enterprise class, tier 3 data center located in Royal Oak, MI, offering a full range of technology solutions, including fully managed, co-located, virtual, dedicated and shared hosting services. Retrieved from https://www.libertycenterone.com/blog/oracle-vs-mysql-vs-sql-server-vs-postgresql-which-dbms-is-the-best-choice-for-you/ on June 5, 2017.
[4] Oracle vs DB2 Shootout by ITGain GmbH in 2015 at the DOAG. Retrieved from https://www.doag.org/formes/servlet/DocNavi?action=getFile&did=7522322 on June 5, 2017.
[5] G2 Crowd Real-time and Unbiased User Reviews. Retrieved from https://www.g2crowd.com/products/oracle-database-12c/reviews on June 6, 2017.

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        - Easy to use and a great support system; a newbie should be able to operate it with ease.
        - If your corporation is large enough, Oracle is one of the better solutions for large enterprise systems.
    - What benefits have you realized?
        - The high availability and partitioning really make this great software.

Microsoft SQL (Structured Query Language) Server (Database Engine)

- Use MS SQL Server if:
    - You're working in a .NET development environment.
    - Your database serves a large corporate/enterprise environment.
    - You're processing workloads rather than developing applications.
    - You require fine-tuned control over your database.

IBM DB2

- Market leader on mainframes.
- Use DB2 if:
    - You already maintain an in-house DB2 installation.
    - You wish to federate data from multiple sources.
    - You need to access data at high speed.
    - Performance optimization is extremely important to your project.
    - For long running queries, DB2 is faster than Oracle. [6]

[6] Oracle vs DB2 Shootout by ITGain GmbH in 2015 at the DOAG. Retrieved from https://www.doag.org/formes/servlet/DocNavi?action=getFile&did=7522322 on June 5, 2017.

Relational Database Management Systems (RDBMS)

- While there are many RDBMS' out there of varying types for all sorts of database needs (MS-Access, Sybase, MySQL (Oracle owned), PostgreSQL, SQLite, etc.), this paper is intended to distinguish between and among what is generally considered the top three major market-leading RDBMS players. [7]

Oracle v12c-r2

- Initial release in 1980.
- Considered an all-around solid market leader choice supporting multiple versions of Windows, Unix, and Linux operating systems (OS).
- For over 30 years' Oracle Corp has produced the most prominent and effective Relational Database Management System (RDBMS) on the market. [8]
  - Considered always consistent across platforms and OS'.
  - Just plain dominates the market.
  - Could see major changes away from Oracle in the next few years.
- In that public cloud infrastructure of tomorrow, AWS, Microsoft Azure, and Google rule. Oracle? Not so much. [9]
- Oracle's IaaS cloud comes in three compute flavors: [10]
  - Physical (meaning non-virtualized)
  - Linux or Windows servers, which offer isolation of customer workloads
  - Virtual servers (where customers share infrastructure resources with other customers)
  - Bare metal servers running Docker containers

  "No one else in the public cloud offers that capability," said Oracle President of Products, Thomas Kurian, about the company's physical servers, which he says provide 100% isolation of workloads.
  Compute offerings range from inexpensive machines ($0.10 per hour) to ones with between 32 and 44 Intel core processors, 1 TB of dRAM and 29 TBs of local storage, all the way up to 60 TB local storage that are capable of up to 1 million input and outputs per second (IOPS).
  Kurain claims these cost 20% less than AWS with 7 to 10X the performance.
- Security is at the core of the coding practices employed by the development staff that builds the Oracle database, resulting in the delivery of a secure product.

[7] Which relational DBMS is best for your company? By Craig S. Mullins of Mullins Consulting. Retrieved from the TechTarget's SearchDataManagement http://searchdatamanagement.techtarget.com/feature/Which-relational-DBMS-is-best-for-your-company on June 5, 2017.
[8] SQL Server on LINUX Perfect Storm Oracle by Michael Corey of Corey and Associates on November 17, 2016. Retrieved from http://michaelcorey.com/blog/sql-server-linux-perfect-storm-oracle/ on June 5, 2017.
[9] Why cloud databases threaten Oracle's lead in the enterprise article by Matt Asay of TechRepublic on October 4, 2016. Retrieved from http://www.techrepublic.com/article/why-cloud-databases-threaten-oracles-lead-in-the-enterprise/ on June 5, 2017.
[10] Oracle outlines plans to take on Amazon in cloud by Brandon Butler, Senior Editor at Network World on January 17, 2017. Retrieved from http://www.networkworld.com/article/3158725/cloud-computing/oracle-outlines-plans-to-take-on-amazon-in-cloud.html on June 5, 2017.

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- Oracle is closed-source – the free version has very limited feature set.
- Many corporate IT folks say they know that Oracle's database outshines Amazon's, but that alone isn't enough to win the day.
  - One consultant summed up the situation perfectly. He was talking to Wall Street analyst Pat Walravens from JMP Securities at the AWS Summit in San Francisco the week of April 17, 2017. Walverens reported the conversation in a research note.
    - Note that Walravens has been a critic of Oracle over the years and currently rates Oracle's stock a "market perform."
    - The consultant said the Oracle database "is a great product, but it can't compete on cost or ease of use... It's like a Formula-1 race car - you need a great driver and a team to look after it." [11]
- Oracle uses PL/SQL (Procedural Language/SQL).
- Temporary tables persist across sessions, and must be removed by the user.
- Has support for four different character/string types: CHAR, VARCHAR2, NCHAR, NVARCHAR2.
- Offers both table and row locking.
- Has extensive and flexible storage customization with commands like tablespace, synonym, and packages.
- Widespread backup mechanisms.
- Designed to manage tables and databases on a large-scale basis.

IBM DB2 for Linux, Unix, Windows (LUW)

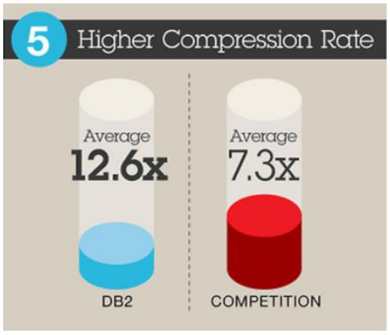
- Initial release in 1983.
- Common in IBM host environments. [12]
- IBM addresses security by delivering it outside of the database and relying on the operating system or Tivoli's product line to secure DB2 and other IBM products. [13]
  - The most obvious result is that data stored in DB2 is not inherently protected.
- DB2 is closed-source – enterprise version only available for a price.
- DB2 is Oracle's biggest competitor on Unix and Linux OS'.
- Faster deployment with an average deployment time of 57 days LESS than an Oracle based solution. [14]
- Multiple options for disaster recovery, availability, and scalability.
- Does not support XML.

[11] This quote perfectly sums up why Oracle should be terrified of Amazon by Julie Bort of Business Insider on April 20, 2017. Retrieved from http://www.businessinsider.com/why-oracle-should-be-terrified-of-amazon-2017-4 on June 5, 2017.

[12] System Properties Comparison DB2 vs. Microsoft SQL Server vs. Oracle by DB-Engines, a knowledge base of relational and NoSQL database management systems. Retrieved from https://db-engines.com/en/system/DB2%3BMicrosoft+SQL+Server%3BOracle on June 5, 2017.

[13] A Comparative Study on Oracle and IBMDB2 Databases, by Lavanya Pamulaparty, P.Vijaya Babu Varma, and T.Praveen Kumar - Professors in the Department of Computer Science and Engineering (CSE) in the Dr. Mahalingam College of Engineering and Technology (MCET), India. Retrieved from http://seekdl.org/nm.php?id=954 on June 5, 2017.

[14] IBM Data Management Blog's Cost/Benefit Comparison of DB2 10.5 and Oracle Offerings by Danny Arnold, Worldwide Competitive Enablement Team on May 27, 2014. Retrieved from https://ibmdatamanagement.co/2014/05/27/comparison-db2-oracle/ on June 5, 2017.



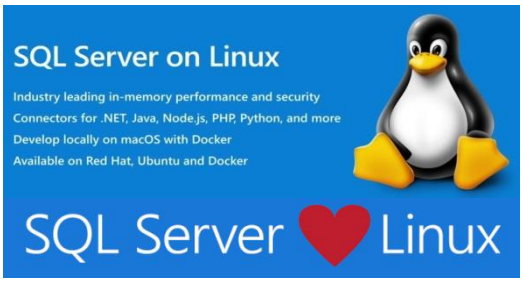
- 5.3X better compression rates for DB2 over Oracle (12.6X for DB2 versus 7.3X for Oracle). [15]
- Schema-based table management.
- Can only partition tables via sharding.
  - Sharding is a type of database partitioning that separates very large databases into smaller, faster, more easily managed parts called data shards. [16]
    Shard means a small part of a whole.
- No in-memory capabilities.
- Designed for relational integrity.
- More robust table/data management than MySQL.
- Materialized table views.
- Lacks native character/string support.

Microsoft SQL Server (Database Engine) v2017 [17]

- Initial release in 1989.
- SQL has been generally considered the database leader on Windows OS.
- Microsoft announced in early 2016 that SQL Server 2016 is now on Linux.
- Gartner named Microsoft as leading the industry in their Magic Quadrant for: [18]
  - 2016 – Operational Database Management Systems (ODMS) in both execution and vision.
  - 2016 – Data Warehouse and Data Management Solutions for Analytics.
  - 2017 – Business Intelligence and Analytics Platforms.
  - Leading in vision in the Magic Quadrant for Advanced Analytics Platforms.
- Uses Transact SQL (T-SQL), which is an extension of SQL originally developed by Sybase. [19]
- Closed-source and aimed at corporate/enterprise environments.
- Offers full support for common table expressions.

[15] IBM Data Management Blog's Cost/Benefit Comparison of DB2 10.5 and Oracle Offerings by Danny Arnold, Worldwide Competitive Enablement Team on May 27, 2014. Retrieved from https://ibmdatamanagement.co/2014/05/27/comparison-db2-oracle/ on June 5, 2017.
[16] TechTarget Definition of Sharding by James Denman. Retrieved from http://searchcloudcomputing.techtarget.com/definition/sharding on June 5, 2017.
[17] What's New in SQL Server 2017 (Database Engine) by Microsoft Docs on May 18, 2017. Retrieved from https://docs.microsoft.com/en-us/sql/database-engine/configure-windows/what-s-new-in-sql-server-2017-database-engine on June 5, 2017.
[18] Announcing SQL Server on Linux by Scott Guthrie of the Official Microsoft Blog on March 7, 2016. Retrieved from https://blogs.microsoft.com/blog/2016/03/07/announcing-sql-server-on-linux/#sm.001h5222956qf4810ge1htu9v5nsi on June 5, 2017.
[19] Microsoft SQL Server vs. Oracle: The Same, But Different? By Josh Stansfield of Segue III Technologies on March 13, 2014. Retrieved from http://www.seguetech.com/microsoft-sql-server-vs-oracle-same-different/ on June 5, 2017.

- Requires a deeper understanding of databases and database configurations than other tools.
- Can fine-tune security features such as who can run each stored procedure; who can access data, etc.
- Utilizes an engine that's slightly slower and resource-heavy, but fully ACID compliant.
  - In computer science, ACID (Atomicity, Consistency, Isolation, Durability) is a set of properties of database transactions. In the context of databases, a sequence of database operations that satisfies the ACID properties and, thus, can be perceived as single logical operation on the data, is called a transaction. For example, a transfer of funds from one bank account to another, even involving multiple changes such as debiting one account and crediting another, is a single transaction. [20]
- SQL on Linux opened up a huge option for organizations looking to switch away from Oracle and their famously aggressive licensing audits.
  - The top 10 triggers (and deterrents) of an Oracle audit article provides an overview of the aggressiveness at: http://upperedge.com/oracle/the-top-10-triggers-and-deterrents-of-an-oracle-audit/



- Extremely comprehensive reporting system/storage customization.
- High degree of control over transactions and procedures.
- Schema changes do not lock tables.
- Relatively high resource footprint.

[20] Wikipedia, the free encyclopedia ACID article. Retrieved from https://en.wikipedia.org/wiki/ACID on June 5, 2017.

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Additional Background Information

- Oracle recognized many years ago that customers are more focused on their Application Software than the RDBMS Software, meaning customers primarily purchase the application first and fit the RDBMS into that plan. Hence, Oracle's integrated Product Suite is considered their final firewall preventing this "Perfect Storm" from totally swamping the intellectual property of Redwood Shores.

- Although Oracle and SQL use a version of Structured Query Language, or SQL:

    - MS SQL Server uses Transact SQL, or T-SQL, which is an extension of SQL originally developed by Sybase and used by Microsoft.
    - Oracle uses PL/SQL, or Procedural Language/SQL.
        - Both are different "flavors" or dialects of SQL and both languages have different syntax and capabilities.
    - Main difference between the two languages is how they handle variables, stored procedures, and built-in functions.
        - PL/SQL in Oracle can group procedures together into packages, which can't be done in MS SQL Server.
        - PL/SQL is generally considered more complex and potentially more powerful, while T-SQL is much more simple and easier to use.

- Why would one use Oracle DB now?
  A comment was made concerning Oracle: "It seems like if you were to pick a database and start from scratch, there would be no reason Oracle would be on the top of the list."
    - The answer is simple, and one that has been answered here 100 times. Oracle has a significant number of more features than just about all of its competitors. There are many things I can do in Oracle that I cannot do in Postgres, MySQL, SQL Server, etc.
    - If you understand how to leverage things like bitmap indexes, sub-partitions, hybrid columnar compression, parallel queries (all things most other databases can't do), and a plethora of other features, you can maximize the living heck out of your hardware and actually end up saving money in the long run.
    - It all depends on use case. Many databases just don't have the right features for some use cases. [21]

[21] Why would one use Oracle DB now? answered by Chris Schrader, Quora Business Intelligence Consultant on Sep 11, 2016. Retrieved from https://www.quora.com/Why-would-one-use-Oracle-DB-now on June 5, 2017.

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- Database Comparisons: [22]

	IBM DB2 x	Microsoft SQL Server x	Oracle x
Description	Common in IBM host environments, two (2) different versions for host and Windows/Linux.	Microsoft's relational DBMS.	Widely used RDBMS
Database Model	Relational DBMS	Relational DBMS	Relational DBMS
Website	www.ibm.com/analytics/us/en/-technology/db2	www.microsoft.com/en-us/sql-server	www.oracle.com/database
Technical Documentation	www.ibm.com/support/entry/portal/-support?brandind=information%20management	technet.microsoft.com/library/-dn237258	docs.oracle.com/en/database/-database.html
Implementation Language	C C++	C++	C C++
SQL - Support of almost the entire SQL standard (DML, DDL, and DCL statements)	Yes	Yes	Yes

[22] System Properties Comparison DB2 vs. Microsoft SQL Server vs. Oracle by DB-Engines, a knowledge base of relational and NoSQL database management systems. Retrieved from https://db-engines.com/en/system/DB2%3BMicrosoft+SQL+Server%3BOracle on June 5, 2017.

API's and other access methods	ODBC JDBC ADO.NET Xquery JSON-style queries (MongoDB compatible)	ODBC JDBC ADO.NET Tabular Data Stream (TDS) OLE DB	ODBC JDBC Oracle Call Interface (OCI) ODP.NET
Supported programming languages	C, C#, C++, Cobol, Delphi, Fortran, Java, Perl, PHP, Python, Ruby, Visual Basic	C++, Delphi, Go, Java, JavaScript (Node.js), PHP, Python, R, Ruby, Visual Basic	C, C#, C++, Clojure, Cobol, Delphi, Eiffel, Erlang, Fortran, Groovy, Haskell, Java, JavaScript, Lisp, Objective C, OCaml, Perl, PHP, Python, R, Ruby, Scala, Tcl, Visual Basic
Max Table Size	2 ZB (Zettabytes) Byte (8 bits) [23] Kilobyte (1,000 Bytes) Megabyte (1,000,**000** Bytes) Gigabyte (1,000,000,**000** Bytes) Terabyte (1,000,000,000,**000** Bytes) Petabyte (1,000,000,000,000,**000** Bytes) Exabyte (1,000,000,000,000,000,**000** Bytes) Zettabyte (1,000,000,000,000,000,000,**000** Bytes)	524,272 TB	4 GB block size When an object instance exists in memory, there is no fixed limit on the number of attributes in the object. But the maximum total amount of memory consumed by an object instance is 4 GB. When an object instance is inserted into a table, the attributes are exploded into separate columns in the table, and the Oracle 1000-column limit applies. [24]

[23] How Big Is A Petabyte, Exabyte, Zettabyte, Or A Yottabyte? by High Scalability in September 2012. Retrived from http://highscalability.com/blog/2012/9/11/how-big-is-a-petabyte-exabyte-zettabyte-or-a-yottabyte.html on July 10, 2017.
[24] Oracle Database Reference from the Oracle Help Center on page 1965 of 1981. Retrieved from https://docs.oracle.com/cd/B28359_01/server.111/b28320/limits003.htm#i288032 on June 5, 2017.

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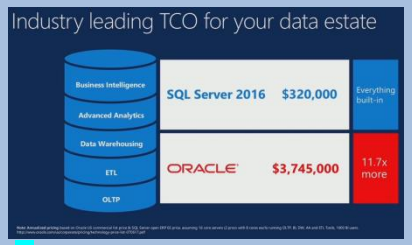
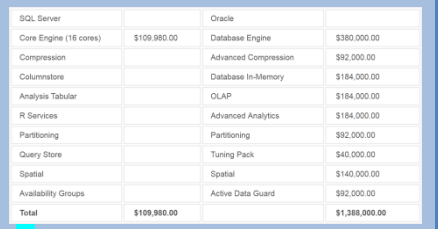
Deadlocks [25] A deadlock is created when two applications lock data that is needed by the other, resulting in a situation in which neither application can continue executing. [26]	Deadlocks are a serious problem under load. "…in the absence of current statistics... the optimizer has to lock, read in, and compare all the rows in the main table with the value supplied in the predicate. Table scans always read (and lock) all the rows in the table. [27]	Deadlocks are a serious problem under load.	Considered more stable than MS-SQL as there are minimal to no deadlocks under load. The Oracle documentation is clear: for a SELECT statement in Oracle, no locks are created. (SELECT...FOR UPDATE is another matter.)
Costs	DB2 10.5 provides a lower total operating cost of ownership than Oracle – 28% to 34% lower 3-year TCO for transactional processing 54% to 63% lower 3-year TCO for high performance analytics. 	 [28]	 [29]

[25] Companies that use Oracle - Why 97% of Fortune 100 Companies use it? by Arvind Sehtia of Sales Inside on July 23, 2016. Retrieved from https://www.salesinsideinc.com/blog/companies-that-use-oracle-why-97-of-fortune-100-companies-use-it on June 5, 2017.

[26] IBM Knowledge Center Database Fundamentals Performance Tuning Lock Management. Retrieved from https://www.ibm.com/support/knowledgecenter/en/SSEPGG_9.7.0/com.ibm.db2.luw.admin.perf.doc/doc/c0005419.html on June 5, 2017.

[27] DB2 vs Oracle -- One Has It All Locked Up by Duke Ganote of Toolbox.com on July 30, 2013. Retrieved from http://it.toolbox.com/blogs/data-ruminations/db2-vs-oracle-one-has-it-all-locked-up-56903 on June 5, 2017.

[28] Microsoft Courting Oracle Users with SQL Server 2016 article by Redmond Magazine in March 2016. Retrieved from https://redmondmag.com/articles/2016/03/10/sql-server-2016-oracle.aspx on July 10, 2017.

[29] Please, Please Stop Complaining about SQL Server Licensing Costs and Complexity article by George Qiao of The SQL Herald: Databases et al.... Retrieved from https://joeydantoni.com/2016/08/18/please-please-stop-complaining-about-sql-server-licensing-costs-and-complexity/ on July 10, 2017.

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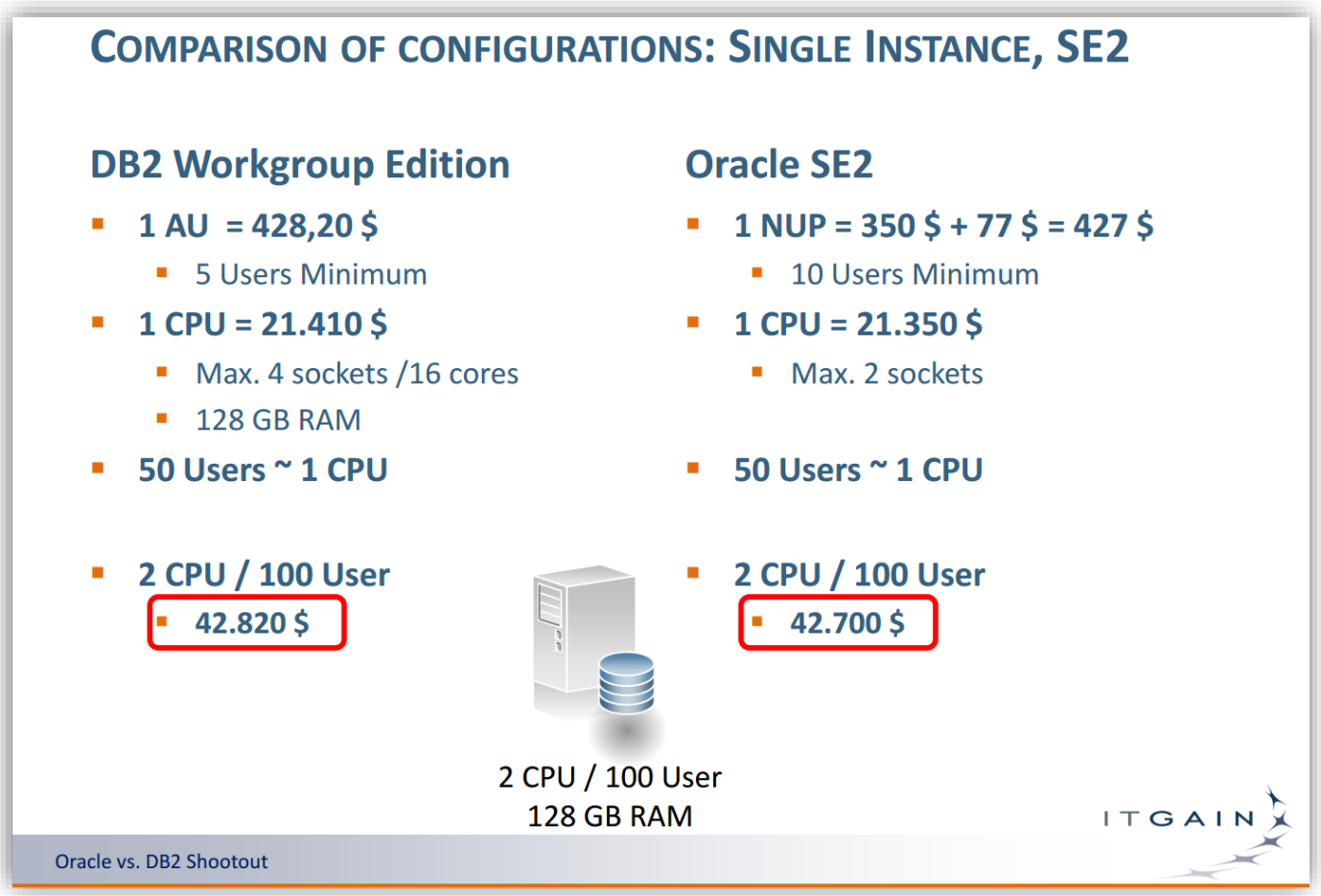
License Model [30]	Processor Value Unit (PVU) Authorized User Single Install License (AUSI or AU) Terabyte Pricing (TB) Pay per whole TB Limited Use Socket (LUS) Licensing by sockets Fixed Term Licence (FTL) License for one year		Processor Named User Plus (NUP)

[30] Oracle vs DB2 Shootout by ITGain GmbH in 2015 at the DOAG. Retrieved from https://www.doag.org/formes/servlet/DocNavi?action=getFile&did=7522322 on June 5, 2017.



DB2 vs Oracle Comparison Configurations Figure 1. [31]

[31] Oracle vs DB2 Shootout by ITGain GmbH in 2015 at the DOAG. Retrieved from https://www.doag.org/formes/servlet/DocNavi?action=getFile&did=7522322 on June 5, 2017.

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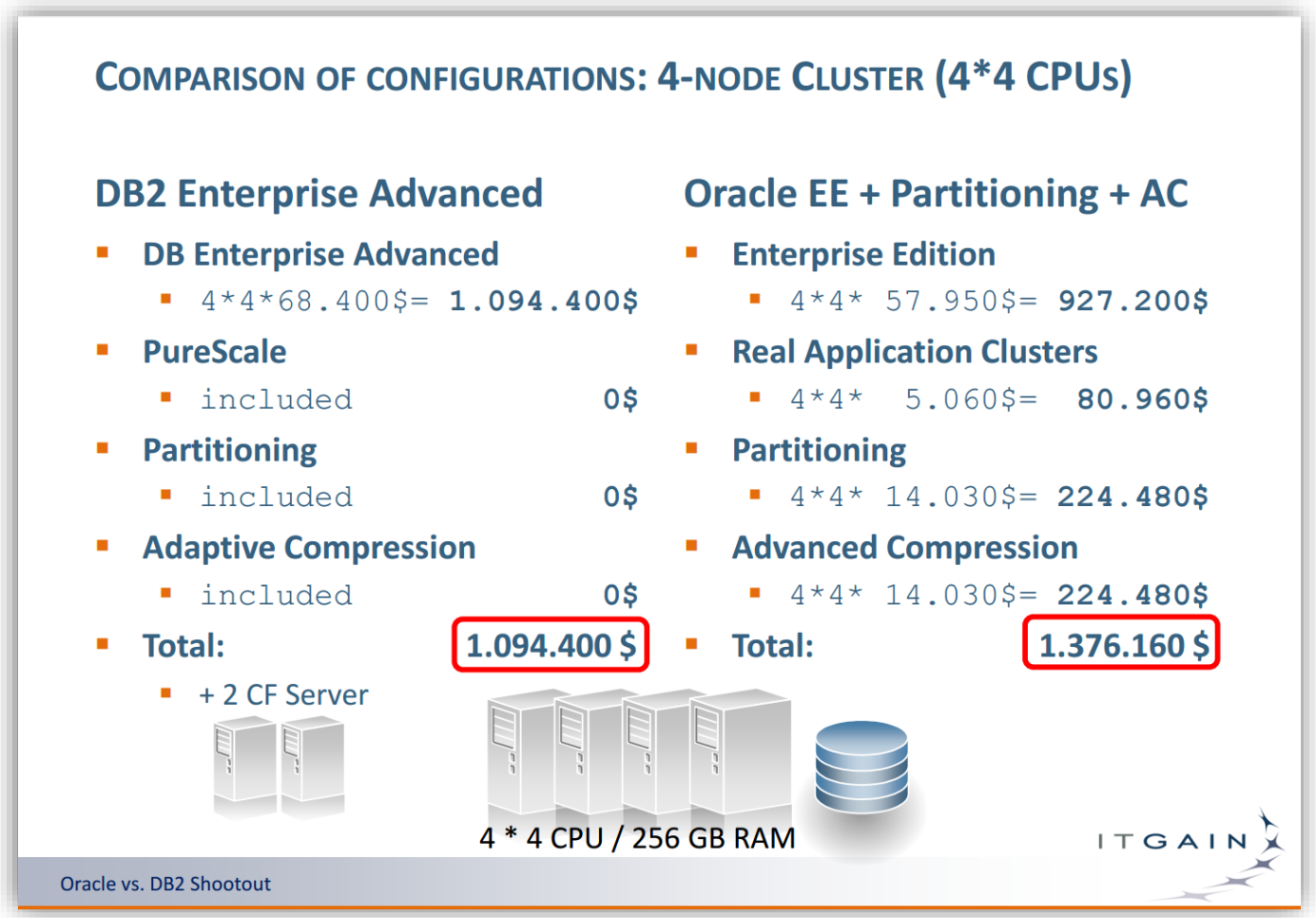

DB2 vs Oracle Comparison Configurations Figure 2. [32]

[32] Oracle vs DB2 Shootout by ITGain GmbH in 2015 at the DOAG. Retrieved from https://www.doag.org/formes/servlet/DocNavi?action=getFile&did=7522322 on June 5, 2017.

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VITA Reference Information (To be removed)

Attachment 1 to Schedule 28.12 to the Comprehensive Infrastructure Agreement Chargeback Services Requirements

https://www.vita.virginia.gov/uploadedfiles/vita_main_public/it_partnership/attachment1toschedule28.12(chargebacksvcrqmnts).ng.final.pdf

5.2 General Requirements p10 of 15

The new replacement Chargeback System will meet the following general VITA requirements:
<snip>
Be able to store data in one or more of the popular databases such as Oracle, DB2, or SQL Server.
<snip>

5.4 Data Capture Requirements (Distributed Systems – UNIX, Windows) p13 of 15

The new replacement Chargeback System will meet the following VITA requirements for chargeback of UNIX and Windows applications:
<snip>
Collect and analyze resource usage across the network customers such as CPU Time, Window Time, Eligible Customer sessions, Database usage (Oracle, DB2, MS SQL 2000, etc.), and others.
<snip>

Commonwealth of Virginia, Virginia Information Technologies Agency (VITA), Supply Chain Division
Issue Date: September 29, 2016
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Single Point of Contact (SPOC): Greg Scearce, VITA Supply Chain Management (SCM)
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https://www.vita.virginia.gov/uploadedFiles/VITA_Main_Public/About/ITS/RFI_2017-14/VITA-RFI_2017-14_Server_Data_Center_and_Security_Services_Microsoft_Response.pdf

Q23. Enhanced Services p19 of 27
As the technology landscape changes in the Commonwealth's environment, could you describe other enhanced services that VITA and VITA Customers should consider in the future?
As outlined above we believe the Commonwealth should consider emerging technologies with a focus on Azure so they can provide the ability to host relational

database products in VMs including SQL Server, IBM DB2, and Oracle database servers. In addition, Microsoft's a PaaS offering SQL Database offers a low administrative overhead of SQL Server in the cloud with automated backup and replication options and almost full compatibility with the on premises version of SQL Server. SQL Data Warehouse provides a PaaS data warehouse offering which offers flexible compute options when are query or processing step requires additional horsepower for a point in time to execute analytics. Additional big data processing options are available with HDInsight as a managed version of Hadoop, Azure Data Lake as an infinitely large data store for big data, and the Power BI and Cortana Analytics Suite for processing, analyzing, and visually enterprise datasets without having to be a data scientist. These technologies support the aforementioned emerging technologies.

ETA Information Domain Report of July 28, 2016 – Version 2.1

Prepared by: Information Domain Team

http://www.vita.virginia.gov/uploadedFiles/VITA_Main_Public/Oversight/EA/ETAInformationDomainReport(1).pdf

Extraction, Transformation and Loading p43 of 54
<snip>
The availability of products such as those from Oracle, IBM, and Microsoft, has definitively changed the landscape of the ETL market, providing a strong push to SQL as the industry standard language for ETL. Those offerings suggest that RDBMSs and SQL have the power to perform any type of ETL process and that SQL code generators are going to be the foundation for coming generations of ETL software solutions.
<snip>

Enterprise Architecture Standard ITRM Standard EA225-05, Section 3 – ETA Database Domain of April 1, 2009

http://www.vita.virginia.gov/uploadedfiles/vita_main_public/library/psgs/ea_psg_update_011510/225_05_sec3.pdf

Section 3. ETA Database Domain

Other Data Access Methods p3 of 6

Table DB-S-01: Database and Other Data Access Methods
Technology Component Standard (Updated April 1, 2009)

Strategic:
Microsoft SQL Server 2005, Microsoft SQL Server 2000
Oracle 9i or 10g
DB2 Version 8.x
MySQL (shall have vendor or equivalent quality level support if used for Mission Critical Applications)

<snip>
Exception History: 02/12/2009: CIO approved adding the MS SQL 2008 DBMS product as a strategic technology
<snip>

Commonwealth of Virginia Enterprise Technical Architecture (ETA) Database Domain Report
Version 1.2, July 1, 2016
Prepared by: Virginia Information Technologies Agency ETA Database Domain Team

https://www.vita.virginia.gov/uploadedFiles/VITA_Main_Public/Oversight/EA/ETADatabaseDomainReport(1).pdf

As-Is Database Architecture p19 of 44
<snip>
Table
Database, Vendor Product Description Reported Agency Usage
Other Data Access Product
2002 | 2003
Oracle With Oracle Database 10g, the first relational database designed for Grid Computing, your information is always available and secure. Oracle Database 10g lowers the cost of ownership through automated management while providing the highest possible quality of service.
136 | 310

SQL Server SQL Server 2000 provides a powerful and comprehensive data management platform. Every software license includes extensive management and development tools, a powerful extraction, transformation, and loading (ETL) tool, business intelligence and analysis services, and new capabilities such as Notification Services.
137 | 209

DB2 DB2 Universal Database is the database management system that delivers a flexible and cost-effective database platform to build robust on demand business applications. DB2 UDB further leverages your resources with broad support for open standards and popular development platforms like J2EE and Microsoft .NET.
5 | 6
<snip>
Technology Component Standards
The technology component standard table below provides strategic technology directions for agencies that are acquiring database and other data access method products.

Table DB-S-01: Database and Other Data Access Methods
Technology Component Standard
(Updated July 1, 2016 to maintain compliance with DB-R-02)

Strategic:

Microsoft SQL Server: versions 2012 and 2014
Oracle: 12.X
DB2: versions 10.x and 11.x
MySQL (shall have vendor or equivalent quality level support if used for Mission Critical Applications)

Redacted Detailed Infrastructure Proposal

http://www.vita.virginia.gov/uploadedfiles/vita_main_public/it_partnership/archive/proposals/redacted_detailed_infrastructure_proposal_-_northrop_grumman/8.0chargebackservicerqmts.pdf

8.0 Chargeback Services Requirements
Requirements: Vendor shall address in its proposal the solution it proposes to the Commonwealth's Chargeback System and Chargeback Services Requirements. The Commonwealth shall submit to Vendor additional instructions and documentation of such requirements shortly after this release of the initial Detailed Package documents.
<snip>
8.7 New/Replacement Chargeback System Requirements
Redacted from Public Document – Proprietary and Confidential
<snip>
8.7.4 Data Capture Requirements (Distributed Systems – UNIX, Windows)
The new replacement Chargeback System will provide the following capabilities and services chargeback for distributed systems with UNIX and Windows environments:
<snip>
3. Collect and analyze resource usage across the network customers such as CPU Time, Window Time, Eligible Customer sessions, Database usage (Oracle, DB2, MS SQL 2000, etc)., and others.
<snip>

COV VITA SCM Division RFI 2017-14 for: Server, Data Center, and Security Services
Issue Date: September 29, 2016
Due Date/Time: October 21, 2016 @ 3:00 pm Eastern
Single Point of Contact (SPOC): Greg Scearce, VITA Supply Chain Management (SCM)
Telephone: (804) 416-6166
E-mail Address: gregory.scearce@vita.virginia.gov

https://www.vita.virginia.gov/uploadedFiles/VITA_Main_Public/About/ITS/RFI_2017-14/ESI_VITA-RFI_2017-14_Server_Data_Center_and_Security_Services_-_Response.pdf

5. QUESTIONS
Please use the table to respond to the Commonwealth's questions.
Ref# Category Question Supplier Response

Q23.
Enhanced Services Page 14 of 21

As the technology landscape changes in the Commonwealth's environment, could you describe other enhanced services that VITA and VITA Customers should consider in the future?

As outlined above, we believe the Commonwealth should consider emerging technologies with a focus on Azure over the next decade so they can provide the ability to host relational database products in VMs including SQL Server, IBM DB2, and Oracle database servers. In addition, Microsoft's PaaS offering SQL Database offers a low administrative overhead of SQL Server in the cloud with automated backup and replication options and almost full compatibility with the on premises version of SQL Server. SQL Data Warehouse provides a PaaS data warehouse offering which offers flexible compute options when are query or processing step requires additional horsepower for a point in time to execute analytics. Additional big data processing options are available with HDInsight as a managed version of Hadoop, Azure Data Lake as an infinitely large data store for big data, and the Power BI and Cortana Analytics Suite for processing, analyzing, and visually enterprise datasets without having to be a data scientist. These technologies support the aforementioned emerging technologies.

Commonwealth of Virginia Information Technology Resource Management Glossary (COV ITRM Glossary)
Version 2.1.a **February, 2017** Virginia Information Technologies Agency

https://www.vita.virginia.gov/uploadedFiles/VITA_Main_Public/Library/PSGs/PSG_Sections/COV_ITRM_Glossary.pdf

<snip>
RAC (Real Application Cluster) p89 of 121
A component of the Oracle **9i** database product that allows a database to be installed across multiple servers. According to Oracle, RAC's shared disk method of clustering databases:
increases scalability because servers can easily be added or subtracted to meet current needs, lowers costs because companies don't have to buy high-end servers, and improves availability because if one server fails, another can assume its workload. RAC's shared disk architecture is an unusual approach to database clustering. Most competing database products (such as Microsoft's SQL Server and IBM's DB2 for Windows and Unix environments) use the alternative, which is known as "shared nothing" architecture. Shared nothing architecture partitions data and only gives each server access to its own disk subsystem, while shared disk architecture gives all servers access to the entire database. This adds failover capacity to the database, because all servers have access to the whole database. Proponents claim that this capacity increases **9i's** reliability and availability significantly. British Telecom, for example, reported that deploying the product

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enabled them to cut their failover time from a typical 20 minutes to between 10-60 seconds.

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